



A.D. 1870, 3rd *NOVEMBER*. N° 2897.

Telegraphs.

LETTERS PATENT to Charles Wheatstone, of 19, Park Crescent, Regent's Park, Knight, and John Matthias Augustus Stroh, of 29, Tolmers Square, Hampstead Road, Mechanician, both in the County of Middlesex, for the Invention of "IMPROVEMENTS IN FAST SPEED ELECTRO-MAGNETIC TELEGRAPHS, AND IN APPARATUS RELATING THERETO."

Sealed the 31st December 1870, and dated the 3rd November 1870.

COMPLETE SPECIFICATION filed by the said Charles Wheatstone and John Matthias Augustus Stroh at the Office of the Commissioners of Patents, with their Petition and Declaration, on the 3rd November 1870, pursuant to the 9th Section of the Patent Law Amendment Act, 1852.

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TO ALL TO WHOM THESE PRESENTS SHALL COME, we, CHARLES WHEATSTONE, of 19, Park Crescent, Regent's Park, Knight, and JOHN MATTHIAS AUGUSTUS STROH, of 29, Tolmers Square, Hampstead Road, Mechanician, both in the County of Middlesex, send greeting.

Wheatstone & Stroh's Improvements in Telegraphs.

WHEREAS we are in possession of an Invention for "IMPROVEMENTS IN FAST SPEED ELECTRO-MAGNETIC TELEGRAPHS, AND IN APPARATUS RELATING THERETO," and have petitioned Her Majesty to grant unto us, our executors, administrators, and assigns, Her Royal Letters Patent for the same, and have made solemn Declaration that we are the first and true Inventors thereof.

NOW KNOW YE, that we, the said Charles Wheatstone and John Matthias Augustus Stroh, do hereby declare that the following Complete Specification, under our hands and seals, fully describes and ascertains the nature of the said Invention, and in what manner the same is to be performed, in and by the following statement:—

On the Second of June 1858 the said Sir Charles Wheatstone obtained Her Majesty's Letters Patent, No. 1239, for "Improvements in Electric Telegraphs and Apparatus connected therewith." This Invention was stated to be "A new combination of mechanism for the purpose of transmitting through a telegraphic circuit messages previously prepared, and causing them to be recorded or printed at a distant station." This telegraphic system consisted of three distinct parts.

1st. Of an instrument for perforating the slips of paper with the apertures required in the order to form the message.

2ndly. Of an apparatus called the transmitter, the object of which was to receive the slips of paper prepared by the perforator and to transmit the currents produced by a voltaic battery or other rheomotor in the order and direction corresponding to holes perforated in the slip. The perforated slip acted upon this transmitter in the same manner as the cards of a jacquard loom does, allowing pins to enter the apertures as they present themselves or remain depressed when the blank intervals pass over them, one row of apertures acting upon the pin, the depression of which determines the current in one direction, and another row on the pin whose depression determines the production of the opposite current.

3rdly. Of a recording or printing apparatus constructed in such manner as to print dots forming what is called the Steinheil alphabet, and also to avoid in the act of printing any friction or resistance which would require additional force for the movement of the styles or pins.

In another Patent subsequently granted to the said Sir Charles Wheatstone on the Tenth of October 1860 (No. 2462), he described a

Wheatstone & Stroh's Improvements in Telegraphs.

modification of the transmitter of the preceeding telegraphic system, the object of which was to enable the transmitter by means of the perforated slips of paper therein described to act upon the receiving instrument of a Morse's telegraph in such manner as to impress on bands of paper in
5 any required order the succession of long and short marks in the same line which constitute the alphabet of that telegraph, instead of the double row of dots required in the former system. The printed lines were determined by currents always in the same direction, and the blank intervals corresponded with cessations of the current.

10 In a more recent Patent, dated the 28th of January 1867 (No. 220), the said Sir Charles Wheatstone described various improvements on the three parts of his telegraphic system which removed many of the former inconveniences and greatly increased its efficiency. The perforator was so constructed that all the perforations required to determine the
15 direction of the currents, and the lengths of the marks and intervals were simultaneously made by a single touch. The transmitter while preserving the essential principle analogous to the jacquard loom which constitutes the chief originality of his Invention was so constructed that only one half of the length of the paper band formerly necessary was
20 required, and the currents in one direction corresponded with the marks, and those in the opposite direction with the blank intervals. The printing portion of the receiving instrument was constructed so that while marking lines no more force was required than that necessary to move the extremely light printing roller, all friction usually employed
25 to supply ink to this roller or to press the paper against the inker being avoided. The way in which these improvements were carried out is fully described in the Specification.

Since the date of the Patent just mentioned we have introduced various practical improvements designed to increase the efficiency of the
30 system, and having made the necessary trials to prove that efficiency, we shall describe in the present Specification,—

1st. The transmitter in its improved form, and point out those parts in which it differs from that previously described.

2ndly. A method of constructing a relay or translator, acting by
35 alternately inverted instantaneous currents, so that the retransmission of the despatches may be effected under the same circumstances as in the original transmission.

Wheatstone & Stroh's Improvements in Telegraphs.

3rdly. A new arrangement of mechanism, by means of which the manual working of one or more perforators may be facilitated without having recourse to hydraulic power.

4thly. A key to be worked by the hand for transmitting alternately inverted currents which last only during its upward or downward motion.

5thly. A manipulating key by which alternately inverted currents of equal duration are transmitted independently of the speed with which the lever is moved.

6thly. An arrangement for adjusting the printing magnet when oscillating between poles of different magnetic intensities.

Transmitter.—Our first improvement consists of a general modification of the transmitting apparatus of a high-speed telegraph with voltaic currents.

In the form of improved transmitter described in No. 1239, A.D. 1858, the rotation of a handle - - - - - actuates "the mechanism which gives motion to the paper strip, and makes the contacts according to the perforations on the paper, and has also like it a rocking piece with a groove to receive the paper strip, a spring clip which holds the paper firmly during the recession of the rocking piece, and three wires or pins placed transversely to the paper strip, which by entering the external apertures thereof, or by being prevented from entering the paper by the absence of apertures, regulate the succession, frequency, and direction of the electric currents sent into the telegraphic circuit."

And in the form of improved transmitter described in No. 220, A.D. 1867, "instead of having a simultaneous vertical motion, the two exterior pins are elevated alternately, one being allowed to rock with the middle pin, the other having only a vertical motion."

In the instrument which forms the present improvement the paper strip instead of having an intermittent motion imparted to it is drawn forwards with a continuous motion. This is accomplished by a spur wheel in connection with the mechanism of the transmitter, the thumbs or teeth upon the periphery of which enter the central row of holes of the paper strip and draw it through. By this means the central pin and rocking piece are dispensed with. The number of vertical wires or pins are reduced to two, which are connected by a system of suitable levers

Wheatstone & Stroh's Improvements in Telegraphs.

with the commutating arrangement for inverting the galvanic currents. A part of this improvement also consists in the introduction of a second commutating arrangement, by which after the ordinary current which determines either a dash or a space has been transmitted a weaker
5 current in the same direction is sent after it.

A front elevation of the improved transmitter is shown in Fig. 1. The perforated paper strip is drawn with an uniform velocity between the fluted roller C and the circular depression in the horizontal ledge B by the spur wheel M, the teeth of which enter into the central line of holes
10 and hold it in position. The vertical wires or pins p , p^1 , which enter respectively into the upper and lower line of perforations of the paper strip are connected with the bell-crank levers I and J, and are forced upwards by the spiral springs s and s^1 . These levers are placed on opposite sides of the rocking beam L, and are alternately depressed by
15 the arms l and c , which protrude from it at equal distances from its centre. When a hole occurs in the paper strip, through which either of the vertical pins is free to enter, the lever attached to it follows the beam upwards, remaining in contact with the arm of the beam on that side, and the circuit remains unbroken; but if no hole occur in the
20 paper strip the vertical pin rising against it is stopped, and the bell-crank lever prevented following the beam upwards. The protruding arm of the beam therefore separates from the lever, and the circuit is interrupted. When either of the vertical wires or pins rises up through a hole in the paper it engages with one of the grooves of the fluted
25 roller C, which carries it forwards until the opposite oscillation of the beam causes it to be withdrawn. The two bell-crank levers I and J are connected together electrically through the brass sides of the clockwork; the brass spiral springs s and s^1 tend to press those levers into contact with the pins l and c of the rocking beam. The arm l is in permanent
30 connection with the line. The rocking beam on its right-hand side is furnished with a third projecting contact arm e in permanent connection with the earth, and which with the arm c on the same side of the centre makes (when the beam oscillates) alternate contact with the opposite faces of the two contact levers G and H. The lever H is in permanent
35 connection through the slab F with the copper pole; the lever G is in permanent connection through the slab E with the zinc pole of the battery. When the right-hand side of the beam is elevated the contact

Wheatstone & Stroh's Improvements in Telegraphs.

arm *e* presses against the face of *G* and puts the zinc pole to earth, at the same time the arm *c* is pressed against *H*, which forms the metallic prolongation of the copper pole. If an aperture occur in the paper strip at this moment the ends of *I* and *J* are in contact with *c* and *l*, and the copper current passes from *H* through *c*, *I*, the springs *s* and *s*¹, *J* to *l*, 5 and line. If on the other hand no aperture occurs in the paper strip, the end of *I* is prevented following the beam, and the line circuit is interrupted on that side by the separation of the contact *c*. When the beam is in the opposite position a similar action takes place, with the difference that the other pole of the battery is then put to earth 10 through *e*, and that the interruption of the line circuit takes place between *l* and *J* in the event of no aperture occurring in the paper strip.

The arrangement for sending a weak current into the line at the end of a dash or space is effected by the automatic insertion of an artificial resistance into the battery and line circuit. This is done by means of 15 the contact lever *K* centred upon a slab *K*¹ between *E* and *F*, and which is in permanent connection with a resistance coil, and thence with the line. The contact lever *K* is moved from side to side against screw points upon *E* and *F* by the rods *I*¹ and *J*¹, coupled respectively to the ends of the bell-crank levers *I* and *J*. The ends of these rods pass 20 through suitable holes in the opposite sides of the lever *K*, but they are supplied with ebonite adjusting nuts, so that whenever either of the vertical pins enters alternately into an aperture in the paper strip one end of its lever follows the rocking beam *L*, whilst the other thrusts the lever *K* far enough to carry it over the centre of the friction wheel *d*, 25 which holds it in place until its position is changed to the other side. When the contact tongue *K* rests against the screw point of *E* a zinc current passes from *E* through *K* resistance and line whenever the beam is depressed on that side, which puts the lever *H* and arm *e* in contact, and therefore copper to earth. The opposite takes place when the 30 tongue rests against the screw point of *F*, a copper current passing from *F* through *K* and the resistance *R* into the line whenever the rocking beam is in the other direction, which puts zinc to earth. And these currents can therefore only occur when the rocking beam returns to the same position it was in when the lever *K* was thrust over. 35 Whenever a full current is sent into the line through the levers *I* and *J* and arms *c* and *l*, a parallel current is also sent through the duplicate

Wheatstone & Stroh's Improvements in Telegraphs.

circuit formed by the resistance and contact tongue; and whenever the beam returns to this position while no aperture occurs in the paper the lever remains unmoved, and a current in the same direction will be sent into the line through the resistance only. In this way, as the last
5 position of the beam during a dash or space is the same as the position which determined the dash or space, although no aperture occurs just then in the paper strip, a weak current is sent in the same direction through the resistance and into the line, because during the formation of the dash or space the lever K has not been thrust from its first position.

- 10 Relay for Induction Currents.—Our second improvement consists of an arrangement by means of which instantaneous and alternately inverted induction currents are transmitted by relay or translator along a line of telegraph instead of voltaic currents, as has hitherto been the case, so that the retransmission of the despatches may be effected under
15 the same circumstances as their original transmission. The apparatus consists of a delicate relay actuated by the alternate instantaneous currents received from the transmitter. The oscillating tongue of this relay makes and breaks connection between the primary wire of an induction coil and a voltaic battery, whilst the corresponding currents
20 induced in the secondary wire of the coil are used for the further transmission along the line.

The manner in which this system is arranged may be seen by the perspective Drawing, Fig. 6. The transmitter indicated in the sketch, may be any form of transmitter from which alternately positive and
25 negative instantaneous currents are sent into the line. At the next station the relay B is placed, the armature of which is oscillated correspondingly with these currents. Suitable contacts attached to the curved magnets of the armature *b* alternately close and break the primary circuit which includes the voltaic battery C and the magnetising
30 wire of the induction coil D. One end of the secondary wire of the induction coil D is connected permanently with earth, the other end being in connection with the second section of the line of telegraph.

Perforator with Treadle.—Our third improvement consists in the arrangement of a perforator for preparing the strips of paper in which
35 the power required to actuate the punches is supplied by means of a treadle and small fly wheel, which imparts a uniform rotating motion to the disc A, Fig. 5. The punches are arranged in three sets placed close,

Wheatstone & Stroh's Improvements in Telegraphs.

side by side and transversely to the path of the paper. Behind the three sets of punches is a hammer or lever C, formed of a flat blade of steel, which is turnable horizontally in two directions upon the centres *c* and *c'* at right angles to each other. The lateral motion for placing it behind one or other of the sets of punches before it is struck forward is imparted 5 by suitable guides brought into action by rods attached to the finger keys H. The forward motion for urging the punches is imparted to it by the screw head *m* when the crank B is elevated. The crank B which is turnable about the centre *b* carries upon its longer arm an eccentric cam D. A projection *d* on the rim of the cam D is held when at rest 10 against the lower end of the trigger E by the force of a flat steel spring *i*, which presses upon a pin on one side of it. The backs of the finger keys H are pressed up against a bell-crank lever G, centred at *g*, and push forward a rod F, which releases the trigger E. When the crank B is at rest upon the india-rubber buffer the cam D is very close to but 15 does not quite make contact with the rotating disc A. When the trigger is released, however, the spring *i* causes the eccentric cam to rotate far enough to bring it into contact with the revolving disc, which carries it round quickly, and in doing so lifts up the one end of the crank, pressing the other end against the hammer C. The cam is only allowed to make 20 one revolution each time a key is depressed. This is provided for as follows:—When the cam rotates, the trigger being centred upon the bell crank B is lifted up with it and its upper end carried beyond the bolt F, so that it is enabled to resume its proper position before the cam has completed its revolution, and to re-engage the projection *d* as the 25 latter comes round. If the operator still continue to press upon the finger key when the lever B falls into its position of rest, the upper end of the trigger E carries down the bolt F with it away from the screw point I, the bolt being held in position only by the spiral spring *s*.

Simple Reversing Key.—Our fourth improvement is a method of 30 constructing a manipulating key for directing into the telegraphic circuit alternately inverted currents from a voltaic battery, which last only during the upward and downward motions of the lever; the separation of the battery from the line and the connection of the latter with earth being effected when the lever reaches the two limits of its 35 motion.

On the insulated stand M, N, (Fig. 2) is mounted the manipulating lever A, B, with its bearing at C. Upon the back of the lever

Wheatstone & Stroh's Improvements in Telegraphs.

are prolongations formed by two metallic blades D and E, which are permanently in connection through spiral wires one with line through the binding screw O, the other with earth through the screw P. The extreme ends of these blades press against the sides of small curved
5 blocks of ebonite, so shaped that when the key is depressed the blades ascend on the right-hand sides, and when it is elevated they descend on the left-hand sides of the blocks. On each side of each of these curved blocks is inserted a small piece of metal flush with the side face of the ebonite, against which the metallic blades rub and make contact in their
10 passage up or down. The two pieces of metal which face each other on the inner sides of the curved blocks are connected to the zinc pole of the battery through the binding screw G. The two metallic contact pieces on the outer sides of the blocks are permanently connected with the copper pole through the binding screw F. By this arrangement
15 when the key is depressed a current is sent into the line in one direction, and while it is being released a current in the opposite direction is transmitted. Between the terminal screws O and P is a vertical metallic pillar H provided with flanges with which the blades D and E make contact at their extreme points of elevation or depression, so that
20 during each ascent or descent before the extreme ends of the blades leave the ebonite blocks they are put into contact with each other, and the line put for an instant into contact with the earth and discharged.

Reversing Key with Fly.—Our fifth improvement consists of an
25 inverting key by which the battery is cut off the moment after its inversion, enabling currents of equal duration to be transmitted into the line independently both of the time the key is allowed to rest at either of its limits and of the rate at which it is moved.

The first part of the instrument consists of an inverting key, which
30 may be of the ordinary construction, and is provided with the usual commutating contacts for inverting the battery between the earth and line terminals. The second part of the instrument consists of a mechanical interruptor which is inserted in the line circuit, and whose velocity of motion determines the duration of the currents sent by
35 the key.

The inverting key is shown in perspective in Fig. 3. It consists of a lever K, K, provided at the back with a spring prolongation A upon

Wheatstone & Stroh's Improvements in Telegraphs.

which on opposite sides are fixed two metallic blades E and L, the former being permanently connected through the spiral wire E¹ with earth, the latter being permanently connected through the spiral wire L¹ with the mechanical interruptor, and thence with the line terminal. The metallic blades play between four contact anvils upon the pillars Z 5 and C and the studs z and c. The pillar C and stud c are connected with the copper pole of the battery, whilst the pillar Z and stud z are connected with the zinc pole. Thus when the blades are elevated against C and Z, zinc is to earth and copper to line; whereas when the key is in its position of rest, as shown in the Drawing, copper is to 10 earth and zinc to line. This portion of the apparatus therefore forms a double current or reversing key, which may also be of the usual construction.

The second part of the instrument is connected with the key by a rod K¹ attached to the vertical prolongation of the lever K. This rod K¹ 15 is coupled to an arm J attached rigidly to a vertical arbor pivotted in a suitable frame F. Attached to a collar on this arbor are two adjustable parallel blade springs s, s¹, the further ends of which embrace two pins, one upon the arm J, and the other upon one side of the oscillating system G, H, I. This oscillating system is carried upon a vertical 20 arbor, upon the lower part of which the quadrant (Q) of a spur wheel engages with a pinion P, the shaft of which carries a fly above it. Half-way up is a block of ebonite I, carrying a small triangular metal slab H in connection with the blade L of the key, through the spiral wire and screw L₂. At the top of the oscillating arbor is a small cross 25 with two contact screws G, G¹, both of which are to earth through the arbor and frame. The slab H is provided with a vertical pin, which, when the system oscillates, rubs against the face of a spring s¹¹ which is connected electrically with the line terminal of the key. The line circuit between the blade L and the line terminal is therefore made and 30 interrupted between the pin on H and the spring s¹¹. When the key is at rest the rod K¹ draws the arm J forwards, and keeps the left-hand spring s pressed against the pin upon the quadrant Q; the oscillating system is therefore held at rest, as is shown in the Drawing, the line spring s¹¹ being pressed from contact with the pin upon H by the front 35 contact screw G, and the line is therefore to earth. When the knob D of the key is depressed, the blades E and L being raised to the upper

Wheatstone & Stroh's Improvements in Telegraphs.

anvils C and Z, the direction of the current is reversed. At the same time the rod K^1 is thrust back, causing the right-hand spring s^1 to press against the pin upon the quadrant Q and make the system rotate as fast as the fly will allow it to. In rotating, the screw G (earth) leaves
5 the spring s^{11} , which falls for an instant upon the pin upon H, thereby completing the line circuit with L_2 and L and allowing a current to pass into the line. This is however immediately afterwards interrupted again by the further screw G^1 , which as it comes round forces the spring s^{11} from the contact pin. When the key is released again the rod K^1 pulls
10 the spring s against the pin of the oscillating system, causing the quadrant and fly to rotate in the opposite direction, and the current (inverted by the blades L and E) to be transmitted in the opposite direction for an instant as the contact pin of H passes by the spring s^{11} . When the key is not in use for transmitting signals it is placed in its
15 position for receiving. For this purpose the metal block B carrying the bearings of the lever K is made turnable about a vertical pin. When receiving therefore the knob of the lever is drawn towards the left by which the blade L is brought to rest upon a stud R connected with the receiving instrument. The horizontal movement of the lever
20 also has the effect of relieving the tension of both the springs s, s^1 , of the interruptor, so as to allow the oscillating system to assume a central position and the pin upon H to rest in contact with the line spring s^{11} . Currents therefore arriving at the station pass from the line terminal over s^{11} , pin on H, L_2 , spiral wire L_1 , blade L, and stud R to the
25 receiving instrument.

Adjustment of Printing Magnet.—Our sixth improvement consists in an adjustment of the printing magnet. When the wire coils upon the two sides of the electro-magnet act with different moments upon the curved permanent steel magnets which oscillate between them we
30 eliminate the difference by introducing the tension of a spiral spring on one side or the other of the zero position. The arrangement for effecting this is shown in Fig. 4. The axis of the printing magnet A, A, is provided with an arm b from which a spiral spring c is stretched to a small fusee chain d, d , passing over suitable pulleys and round a
35 small drum with a micrometer screw and graduated dial. When the micrometer screw is turned so as to cause the fusee chain to bring the lower end of the spring c in a line parallel with the axis of the printing

Wheatstone & Stroh's Improvements in Telegraphs.

magnet no tension is put upon the latter, whilst by turning it to either side a bias is given to the deflection upon that side of the neutral position of the magnet, and the inequality in the moments of the electro-magnet coils is thus balanced.

In witness whereof, we, the said Charles Wheatstone and John 5
Matthias Augustus Stroh, have hereunto set our hands and seals,
this Thirty-first day of October, in the year of our Lord One
thousand eight hundred and seventy.

CHARLES WHEATSTONE.

(L.S.)

JOHN MATTHIAS AUGUSTUS STROH.

(L.S.)

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LONDON:

Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1870.

FIG. 1.

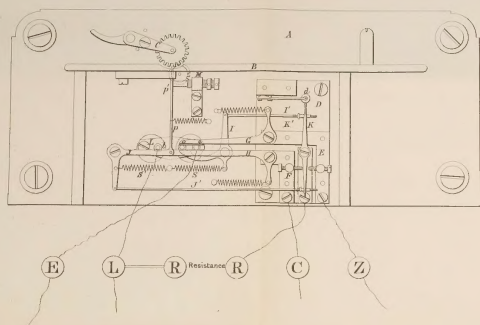


FIG. 5.

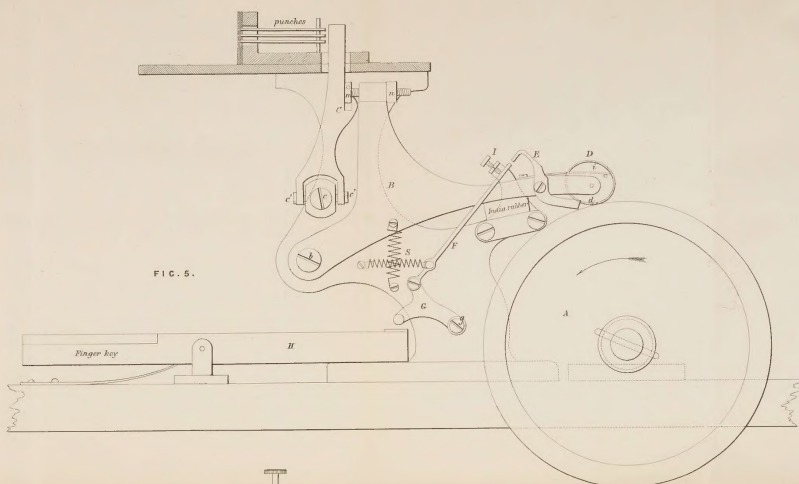


FIG. 3.

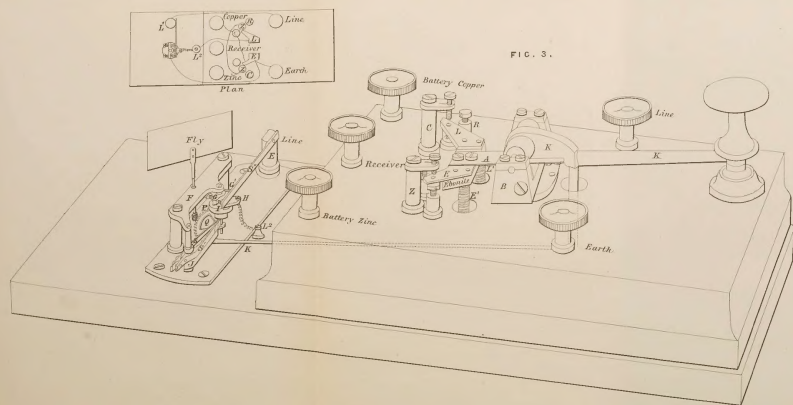


FIG. 4.



FIG. 6.

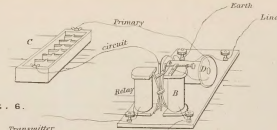


FIG. 2.

